# CLAIMS

1. Multi-user detection method with elimination of interference between users, each user transmitting modulated data in the form of symbols on a transmission channel, each transmission channel ($k$) comprising at least one propagation path ($i$) and each propagation path arriving at an array of reception antennae ($\ell$) according to a direction of arrival ($\theta_{i,k}$), the method comprising at least one sequence of steps for each user ($k$), characterised in that each sequence comprises:

(a) a reception step ($600_k$,$700_k$,$800_k$,800,900) decomposing each antenna signal into filtered signals ($x_{\ell,i,k}$) issuing from the different paths ($i$) of the said user ($k$) and combining the said filtered signals by means of a first plurality of coefficients ($b_{\ell,i,k}$, $c_{i,k}$) in order to form an estimation ($z_k$) of the signal transmitted by the user;

(b) a step of estimating ($670_k$,$770_k$,$870_k$,870,970) the contribution ($(x_{\ell,k})$ $\ell$=1..$L$) of the user to the signals received by the different antennae from the said estimation of the signal transmitted and a second plurality of coefficients ($u_{i,k}$, $w_{\ell,i,k}$) obtained from the said first plurality of coefficients;

(c) a step of eliminating interference ($680_{k'}$,$780_k$,$880_k$,880,980) subtracting from the antenna signals the contribution estimated at step (b) in order to obtain cleaned antenna signals;

the cleaned antenna signals supplied by at least one first sequence being used as antenna signals by at least one second sequence.

2. Multi-user detection method according to Claim 1, characterised in that the first plurality of coefficients comprises a first set of complex coefficients ($b_{\ell,i,k}$) and a second set of complex coefficients ($c_{i,k}$) and in that the filtered signals ($x_{\ell,i,k}$) are subjected to a channel formation step ($420_k$) in order to form signals of paths ($y_{i,k}$) by means of the said first set, the said path signals then being linearly combined ($440_k$) by means of the said second set in order to supply the said estimation ($z_k$) of the signal transmitted, the coefficients of the first set being adapted so as to minimise a plurality of first error signals ($\varepsilon_{i,k}$) between a reference value ($q_k$) of the transmitted signal and the said path signals ($y_{i,k}$), the coefficients of the said second

set being adapted so as to minimise a second error signal ($\varepsilon''_k$) between the said estimation ($z_k$) and the said reference value.

3. Multi-user detection method according to Claim 2, characterised in that the said second plurality ($w_{\ell,i,k}, u_{i,k}$) of coefficients comprises a first set of complex coefficients ($w_{\ell,i,k}$) and a second set of complex coefficients ($u_{i,k}$), the coefficients ($w_{\ell,i,k}$) of the said first set of the second plurality being obtained from the arguments of the coefficients ($b_{\ell,i,k}$) of the first set of the first plurality and the coefficients ($u_{i,k}$) of the said second set of the second plurality being obtained from coefficients ($c_{i,k}$) of the said second set of the first plurality.

4. Multi-user detection method according to Claim 3, characterised in that the coefficients ($u_{i,k}$) of the said second set of the second plurality are obtained by conjugation of the coefficients ($c_{i,k}$) of the second set of the first plurality.

5. Multi-user detection method according to Claim 3 or 4, characterised in that the coefficients ($w_{\ell,i,k}$) of the said first set of the second plurality are obtained from a linear regression on the arguments of the coefficients ($b_{\ell,i,k}$) of the first set of the first plurality.

6. Multi-user detection method according to one of Claims 2 to 5, characterised in that, at the first sequence,

the coefficients ($b_{\ell,i,k}$) of the first set of the first plurality are initialised by $b_{\ell,i,k}(0)=\delta(\ell-\ell_0),\forall i$ where $\delta$ is the Dirac symbol, $\ell_0$ is an antenna number;

and in that the coefficients ($c_{i,k}$) of the second set of the first plurality are initialised by $c_{i,k}(0)=c,\forall i$ where $c$ is a given complex coefficient.

7. Multi-user detection method according to one of Claims 2 to 5, characterised in that, at the first sequence, the coefficients ($b_{\ell,i,k}$) of the first set of the first plurality are initialised by $b_{\ell,i,k}(0)=\exp(-j(\hat{\nu}_{i,k}(0)+2\pi d/\lambda.\cos\hat{\theta}_{i,k}(0).(\ell-1)))$ and in that the coefficients ($c_{i,k}$) of the second set of the first plurality are initialised by $c_{i,k}(0)=\hat{\alpha}_{i,k}(0)$ where $\hat{\theta}_{i,k}(0)$, $\hat{\nu}_{i,k}(0)$, $\hat{\alpha}_{i,k}(0)$ are respectively estimations of the directions of arrival, phase rotations and coefficients of attenuation for the different paths.

8. Multi-user detection method according to Claim 1, characterised in that the first plurality of coefficients consist of a set of complex coefficients ($b_{\ell,i,k}$) and in that the filtered signals ($x_{\ell,i,k}$) are linearly combined ($520_k$) by means of said set in order to supply said estimation ($z_k$) of the signal transmitted, the coefficients of said set being adapted so as to minimise an error signal ($\varepsilon_k$) between the said estimation ($z_k$) and a reference value ($q_k$).

9. Multi-user detection method according to Claim 8, characterised in that the said second plurality ($w_{\ell,i,k}, u_{i,k}$) of coefficients comprises a first set of complex coefficients ($w_{\ell,i,k}$) and a second set of complex coefficients ($u_{i,k}$), the coefficients ($u_{i,k}$) of the said second set of the second plurality being obtained by: $u_{i,k}=g_{i,k}/g_k$ where $g_{i,k}$ is an estimation of the norm of the sub-vector $\bar{\mathbf{b}}_{i,k}=\begin{pmatrix} b_{1,i,k} \\ b_{2,i,k} \\ \vdots \\ b_{L,i,k} \end{pmatrix}$, L being the number of antennae in the array, where $g_k$ is a mean of the $g_{i,k}$ values on the different paths, the coefficients ($w_{\ell,i,k}$) of the said first set of the second plurality being obtained from the arguments of the coefficients ($b_{\ell,i,k}$) of the said set of the first plurality.

10. Multi-user detection method according to Claim 8 or 9, characterised in that, at the first sequence, the coefficients ($b_{\ell,i,k}$) of the said set of the first plurality are initialised by $b_{\ell,i,k}(0)=b\cdot\delta(\ell-\ell_0),\forall i$ where $\delta$ is the Dirac symbol, $\ell_0$ is an antenna number and $b$ a given complex coefficient.

11. Multi-user detection method according to Claim 8 or 9, characterised in that, at the first sequence, the coefficients ($b_{\ell,i,k}$) of the said set of the first plurality are initialised by $b_{\ell,i,k}(0)=\hat{\alpha}_{i,k}(0).\exp(-j(\hat{v}_{i,k}(0)+2\pi d/\lambda.\cos\hat{\theta}_{i,k}(0).(\ell-1)))$ where $\hat{\theta}_{i,k}(0)$, $\hat{v}_{i,k}(0)$, $\hat{\alpha}_{i,k}(0)$ are respectively estimations of the directions of arrival, phase rotations and coefficients of attenuation for the different paths.

12. Multi-user detection method according to one of the preceding claims, characterised in that, for a given user ($k$), the interference is eliminated by subtracting ($680_k$,$880_k$,880,980) from the antenna signals of the contributions of all the other users.

13. Multi-user detection method according to Claim 12, characterised in that each sequence comprises a step of estimating ($610_k$,$710_k$,$810_k$,810,910) the symbols transmitted from the estimation of the signal transmitted ($z_k$) in order to obtain first estimated signals ($\hat{s}_k$), a step of demodulating ($620_k$, $720_k$,$820_k$,820,920) the first estimated symbols ($\hat{s}_k$) in order to obtain estimated data ($\hat{d}_k$), a step of channel decoding ($630_k$,$730_k$,$830_k$,830,930) of the said estimated data followed by a channel recoding ($640_k$,$740_k$,$840_k$,840,940) and a remodulation ($650_k$,$750_k$,$850_k$,850,950) in order to obtain second estimated symbols ($\hat{s}'_k$).

14. Multi-user detection method according to Claim 2 or 13, or 8 and 13, characterised in that the reference value ($q^{(n)}{}_k$) for a transmitted signal, used at the second sequence or at a subsequence sequence ($n$), is the second estimated symbol ($\hat{s}'^{(n-1)}{}_k$) obtained for this signal at the previous sequence.

15. Multi-user detection method according to Claim 2 or 14, or 8 and 14, characterised in that the reference value ($q^{(n)}{}_k$) for a transmitted signal, used at the second sequence or at a subsequent sequence ($n$), is a combination of the first estimated symbol ($\hat{s}^{(n)}{}_k$) obtained for this signal at the current sequence and of the second estimated symbol ($\hat{s}'^{(n-1)}{}_k$) obtained for this signal at the previous sequence.

16. Multi-user detection method according to one of the preceding claims, characterised in that, at the second sequence and at the subsequent sequences, the coefficients of the first plurality of a sequence are initialised from the values of coefficients of the first plurality of the previous sequence.

17. Multi-user detection method according to one of Claims 1 to 11, characterised in that the users are classified in order of received power and in that the interference is eliminated by subtracting ($780_k$), one after the other, the contributions of the different users, commencing with the users with the highest received powers.

18. Multi-user detection method according to Claims 6 and 17, characterised in that, for each sequence of a user ($k$), the coefficients ($b_{\ell,i,k}$) of the first set of the first

plurality are initialised by $b_{\ell,i,k}(0)=\delta(\ell-\ell_0),\forall i$ where $\delta$ is the Dirac symbol, $\ell_0$ is an antenna number;

and in that the coefficients ($c_{i,k}$) of the second set of the first plurality are initialised by $c_{i,k}(0)=c,\forall i$ where $c$ is a given complex coefficient.

19. Multi-user detection method according to Claims 7 and 17, characterised in that, for each sequence of a user ($k$), the coefficients ($b_{\ell,i,k}$) of the first set of the first plurality are initialised by $b_{\ell,i,k}(0)=\exp(-j(\hat{v}_{i,k}(0)+2\pi d/\lambda.\cos\hat{\theta}_{i,k}(0).(\ell-1)))$ and in that the coefficients ($c_{i,k}$) of the second set of the first plurality are initialised by $c_{i,k}(0)=\hat{\alpha}_{i,k}(0)$ where $\hat{\theta}_{i,k}(0)$, $\hat{v}_{i,k}(0)$, $\hat{\alpha}_{i,k}(0)$ are respectively estimations of the directions of arrival, phase rotations and coefficients of attenuation for the different paths.

20. Multi-user detection method according to Claims 10 and 17, characterised in that, for each sequence of a user ($k$), the coefficients ($b_{\ell,i,k}$) of the said set of the first plurality are initialised by $b_{\ell,i,k}(0)=b\cdot\delta(\ell-\ell_0),\forall i$ where $\delta$ is the Dirac symbol, $\ell_0$ is an antenna number and $b$ a given complex coefficient.

21. Multi-user detection method according to Claims 11 and 17, characterised in that, for each sequence of a user ($k$), the coefficients ($b_{\ell,i,k}$) of the said set of the first plurality are initialised by $b_{\ell,i,k}(0)=\hat{\alpha}_{i,k}(0).\exp(-j(\hat{v}_{i,k}(0)+2\pi d/\lambda.\cos\hat{\theta}_{i,k}(0).(\ell-1)))$ where $\hat{\theta}_{i,k}(0)$, $\hat{v}_{i,k}(0)$, $\hat{\alpha}_{i,k}(0)$ are respectively estimations of the directions of arrival, phase rotations and coefficients of attenuation for the different paths.

22. Multi-user detection method according to Claim 12, characterised in that, the estimations of the transmitted signals of the users being considered to be an estimations vector with K components where K is the number of users, the said vector is subjected to a transverse matrix filtering (805,905).

23. Multi-user detection method according to Claim 22, characterised in that, the estimated symbols of the users being considered to be a symbols vector with K components, the said symbols vector is subjected to a postcursor matrix filtering (907) and the output of this filtering is subtracted, vector by vector, from the output of the transverse matrix filtering (905).

24. Multi-user detection device, characterised in that it comprises means adapted to implement the method according to one of the preceding claims.